Fishery Data Series No. 09-21

Aerial Monitoring of Dolly Varden Overwintering Abundance in the Anaktuvuk, Ivishak, Canning, and Hulahula Rivers, 2006-2008.

Final Report for Study 06-108
USFWS Office of Subsistence Management
Fisheries Division

by

Tim Viavant

April 2009

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye to fork	MEF
mideye to tail fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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ABSTRACT

Aerial counts of Dolly Varden *Salvelinus malma* in overwintering index areas were conducted by helicopter in the Anaktuvuk and Ivishak rivers during September of 2006, 2007, and 2008. Counts were conducted in overwintering index areas on the Canning and Hulahula rivers during September of 2007 and 2008. Counts were conducted within defined index areas. Index areas were established in the Anaktuvuk and Ivishak rivers during previous studies conducted in 2001-2003. Index areas in the Canning and Hulahula rivers were established during preliminary surveys flown in 2007. Counts varied between years by as much as a factor of two, but for those rivers with comparable previous data, the counts from 2006 to 2008 were within the range of historical values.

Key words: Dolly Varden, *Salvelinus malma*, abundance, aerial surveys, Beaufort Sea drainages.

INTRODUCTION

Dolly Varden *Salvelinus malma* are found in most of the major Beaufort Sea drainages of the Eastern North Slope of the Brooks Range, from the Canadian border to the Colville River and its tributaries (Figure 1). These fish are mostly anadromous and have complex life history and migration patterns (DeCicco 1985, 1989, 1992, 1997; Craig 1977; Morrow 1980). Juveniles rear for 3-5 years in their natal streams, then migrate to the Beaufort Sea to feed during each summer for the remainder of their lives. Because of the extreme conditions that occur during the winter months, these fish all return to fresh water to overwinter every year, whether spawning during that year or not.

Adults spawn multiple times during their lives, the timing of spawning is variable and fish do not typically appear to spawn in consecutive years (Yoshihara 1973). Many drainages appear to contain spawning stocks that spawn both in late summer (late July through late August) and in late fall (late September through mid-October). Although adults may overwinter in drainages other than their natal spawning drainage, these fish appear to have high fidelity to their drainage of origin for spawning (Reynolds 1997; Furniss 1975, Crane et al. 2005). Genetic studies of anadromous Dolly Varden from North Slope drainages (Everett et al. 1997; Krueger et al. 1999) indicated that there are distinct genetic differences among spawning stocks from individual drainages or groups of drainages.

Although these fish are found in almost all of the major drainages, and spawn and rear in many third and fourth order tributaries, the majority of adults appear to overwinter in specific areas of several first and second order drainages. These overwintering areas appear to be associated with groundwater input as evidenced by areas of year-round open water and the formation of aufies fields.

Fish from these stocks are a well-utilized subsistence resource, and are harvested by residents of Kaktovik, Nuiqsut, Barrow, and Anaktuvuk Pass (Craig 1987; Pedersen 1990, Fall and Utermohle 1995, Brower and Opie 1996, 2000). These fish can be an important component of the subsistence diet in an area, and represent up to 40% of all subsistence fish harvests in Kaktovik (Pedersen 1990). These populations also provide for sport fisheries on the North Slope, with annual harvests from 1996 to 2005 averaging 892 fish and annual catches averaging 3,954 fish from the entire North Slope from 1996 to 2005 (Scanlon 2008).

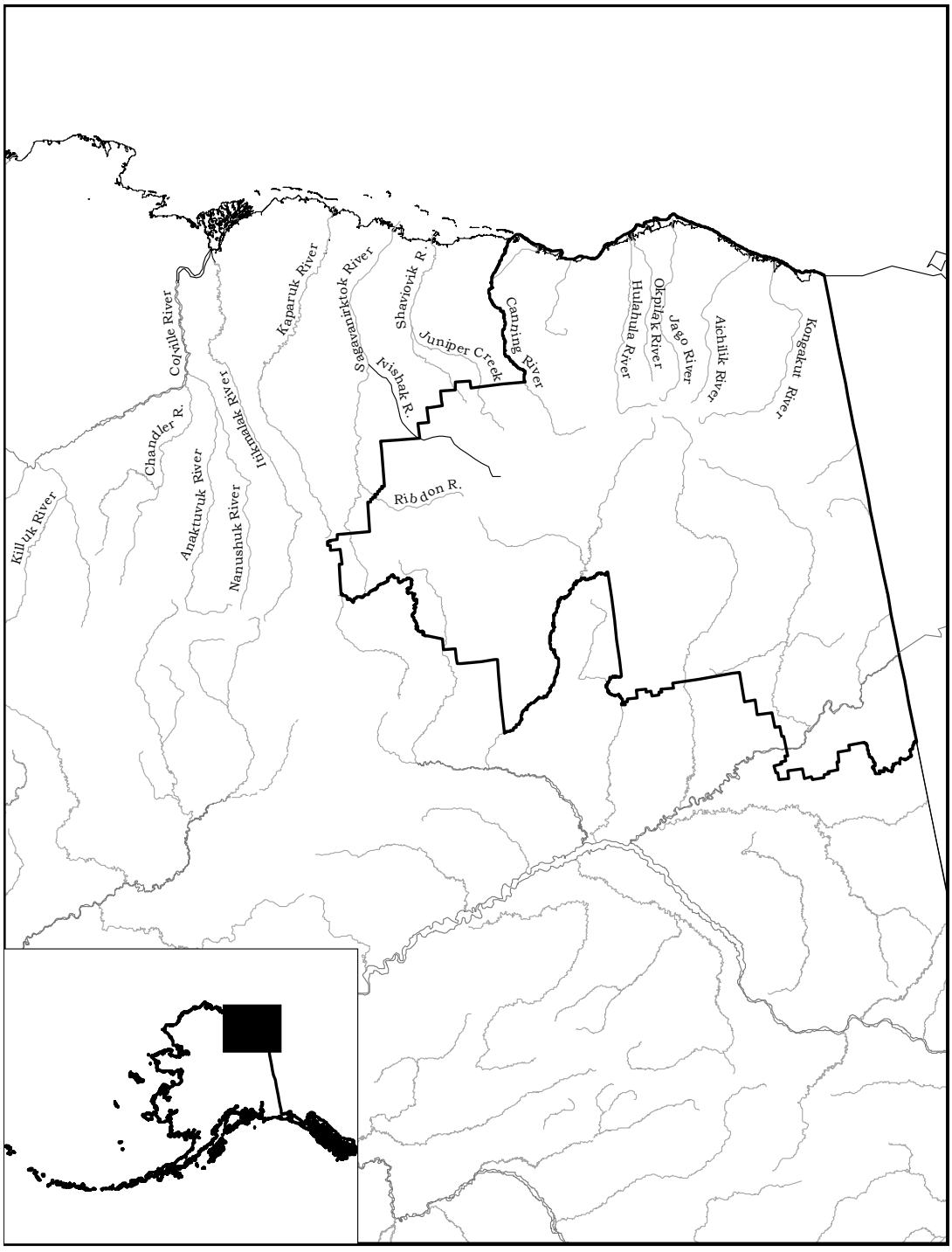

Figure 1.–Map of the eastern North Slope of the Brooks Range and coastal plain showing major drainages containing anadromous Dolly Varden and the boundary of the Arctic National Wildlife Refuge.

Information on these fish stocks is mostly limited to investigations of life history and distribution (Yoshihara 1972, 1973; Furniss 1975; Craig 1977, 1989; McCart 1980; Bendock 1980, 1982, 1983; Bendock and Burr 1984, 1985; Underwood et al. 1996). Prior to 2001, available information on stock status of North Slope Dolly Varden consisted of aerial surveys of overwintering areas on the Anaktuvuk, Ivishak, and Kongakut rivers (Table 1). These surveys only provided a relative index of abundance, and had not been validated as to their repeatability or their relationship to abundance as determined by other assessment methods.

Table 1.–Aerial survey counts of Dolly Varden from the Ivishak, Anaktuvuk, and Kongakut rivers of the North Slope.

Year[a]	Date	Ivishak River	Anaktuvuk River	Kongakut River	Survey Aircraft[b]	Survey Rating	Data Source
1971	22-Sept.	24,470			H	Good	Yoshihara 1972
1972	24-Sept.	11,937			H	Good	Yoshihara 1973
1973	11-Sept.	8,992			H	Excellent	Furniss 1975
1974	10-Sept.	11,000			H	Not Rated	Furniss 1975
1975	22-Sept.	8,306			H	Not Rated	ADFG *Unpublished*
1976	22-Sept.	8,570			H	Fair	ADFG *Unpublished*
1979	22-Sept.	24,403	15,717		FW	Excellent	Bendock 1980
1981	22-Sept.	24,873	10,536		FW	Excellent	Bendock 1982
1982	22-Sept.	36,432	6,222		FW	Excellent	Bendock 1983
1983	22-Sept.	27,820	8,743		FW	Excellent	Bendock and Burr 1984
1984	22-Sept.	24,818	5,462		FW	Excellent	Bendock and Burr 1985
1986	No survey			8,900		Not Rated	USFWS *Unpublished*
1989	22-Sept.	12,650		6,355	H	Good	ADFG *Unpublished*
1993	3-Sept.	3,057			H	Good	USFWS *Unpublished*
1995	27-Sept.	27,036		14,080	H	Good	ADFG *Unpublished*

[a] No surveys were done for years not listed.

[b] Survey aircraft was either a helicopter (H) or fixed wing aircraft (FW: Piper Super Cub).

Between 2001 and 2003, a study was conducted that investigated the precision and accuracy of aerial surveys of overwintering Dolly Varden on the Ivishak River (Viavant 2005). This study determined that aerial surveys under these conditions were relatively precise, and that these surveys consistently counted approximately 23 percent of the population as measured by mark/recapture methods. During this study, the boundaries of overwintering index areas were established for the Ivishak and Anaktuvuk rivers.

The Ivishak, Kongakut, and Anaktuvuk rivers support the largest documented overwintering populations of anadromous Dolly Varden of all the drainages of the Beaufort Sea west of Demarcation Point (Bendock 1980, 1982, 1983, Craig 1989, Furniss 1975, Yoshihara 1972, 1973). The Hulahula and Canning rivers also support overwintering populations for which there is no abundance information (Craig 1977, 1989). Because there are significant subsistence harvests from these populations, there is a need for a minimal level of ongoing monitoring of these stocks. This project provided for index monitoring of the overwintering abundance of Dolly Varden stocks from four of the five major overwintering systems on the North Slope.

OBJECTIVES

The objective of the project was to conduct a single aerial index count of the overwintering abundance of Dolly Varden within established index areas in the Anaktuvuk, Ivishak, Canning, Hulahula, and Kongakut rivers during mid-September of 2006, 2007, and 2008. An additional objective during 2006 was to establish the boundaries of Dolly Varden overwintering index areas in the Canning, Hulahula, and Kongakut rivers.

METHODS

All counts were conducted within fixed index areas. These areas were established in the Ivishak and Anaktuvuk rivers during a previous study (Viavant 2005). The index areas on the Canning and Hulahula rivers were established during the first successful surveys of this study based on the geographic extent of the presence at least 90% of observed overwintering Dolly Varden during that year's survey. Once index areas were established, all counts were conducted within the same established index area. The lengths and waypoints defining these index areas appear in Table 2. All GPS waypoints reported are in NAD 27 Datum, degrees-decimal degrees (dd.dddd) format. Counts were conducted each year between September 17 and September 21.

Table 2.–Boundaries and lengths of index areas used for overwintering abundance counts of Dolly Varden on North Slope rivers, 2006-2008.

River	Index Area Upstream Boundary	Index Area Downstream Boundary	Index Area Length (km)
Anaktuvuk	N 68.8831, W -151.1679	N 69.2620, W 151.0272	40
Ivishak	N69.1022, W -148.0193	N 69.3266 W 148.1960	28
Canning	N 68.9833, W -145.6667	N 69.6682, W 146.2671	86
Hulahula	N 69.1911, W – 144.5601	N 69.7577, W 144.1526	69

Aerial counts were conducted from a helicopter, travelling from upstream to downstream at approximately 50 m above the river, flying at approximately 40 km/hr. Counts were normally conducted by two observers, one counting each side of the river during the survey. In areas of multiple channels, the channel with the majority of flow was counted. Counts were recorded on mechanical counters during each survey. Survey conditions were categorized and recorded as poor, fair, or excellent for each survey.

RESULTS

Successful aerial counts were conducted on the Anaktuvuk and Ivishak rivers in 2006, 2007 and 2008 (Table 3). Poor weather and logistical problems precluded conducting counts on the Canning and Hulahula in 2006, but index areas were established and counts were completed for both rivers in 2007 and 2008. During 2008, weather and staffing problems made it necessary to conduct counts on the Canning, Hulahula, and Anaktuvuk rivers with only one observer counting. The aerial count of Ivishak River in 2008 was conducted with two observers. Weather, logistical problems with helicopter and fuel availability, and staffing problems prevented successfully conducting surveys on the Kongakut River during each year of the study.

Table 3.–Aerial counts of overwintering Dolly Varden from index areas in the Anaktuvuk, Ivishak, Canning, and Hulahula rivers, conducted September 17-21, 2006-2008.

	2006		2007		2008	
River	Count	Survey Conditions	Count	Survey Conditions	Count	Survey Conditions
Anaktuvuk	5,477	Fair	5,807	Excellent	9,660[a]	Excellent
Ivishak	5,411	Excellent	6,520	Excellent	11,914	Excellent
Canning	No Survey		3,936	Excellent	7,533[a]	Excellent
Hulahula	No Survey		9,575	Excellent	3,653[a]	Excellent

[a] Aerial count conducted by one observer only.

DISCUSSION

Index counts of overwintering abundance from the Anaktuvuk and Ivishak rivers increased during each of the three years of the study, and showed substantial increases between 2007 and 2008. All of the counts from these two rivers were within the range of recent previous counts, except that counts for 2008 were the highest of any recent comparable counts (Table 4).

Recent (2001–2008) aerial counts of Dolly Varden from the Ivishak and Anaktuvuk are not directly comparable to the historical counts from 1971 to 1995 (Table 1). Earlier counts were conducted over survey areas that were not standardized and may not have been the same as those used in 2001–2008. While recent counts cannot be compared directly to historical counts, it is noteworthy that for both the Anaktuvuk and Ivishak rivers, the aerial index counts from 2006 and 2007 are at or below the lower end of the range of historical counts, but counts from 2008 for both of these rivers were within the range of those earlier counts.

Table 4.–Aerial counts of overwintering Dolly Varden from established index areas of the Ivishak and Anaktuvuk rivers, Alaska[a]

Year	Ivishak River	Survey Date	Survey Conditions	Anaktuvuk River	Survey Date	Survey Conditions
2001	10,932	9/21/2001	Excellent	No Survey		
2002	5,408	9/20/2002	Excellent	4,576[b]	9/22/2002	Excellent
2003	2,720	9/21/2003	Excellent	5,034	9/18/2003	Fair
2006	5,411	9/18/2006	Excellent	5,477	9/21/2006	Fair
2007	6,520	9/19/2007	Excellent	5,807	9/17/2007	Excellent
2008	11,914	9/18/2008	Excellent	9,660	9/20/2008	Excellent

[a] Counts of the Ivishak River from 2001 to 2003 are averages of five replicate surveys (Viavant 2005), the survey date listed is the midpoint of the survey dates, all other counts are single counts.

[b] Survey conducted in 2002 was an incomplete survey.

The 2008 count from the Canning River showed a substantial increase over the 2007 count, while the 2008 count from the Hulahula River decreased to less than half the 2007 count. These counts do not comprise a meaningful time series and should not be used to infer trends in abundance. A number of factors not directly related to Dolly Varden overwintering abundance could contribute to these results. Aerial counts in general have high variability, and are effected by survey conditions and observer and pilot experience. Counts from 2007 were conducted by two observers, but counts in 2008 were only conducted by one observer. Annual differences in the timing of in-migration could influence counts, however, previous studies indicate that the majority of overwintering fish are present in overwintering areas by mid-September (Viavant 2005, Yoshihara 1973). The variation in the counts from these two rivers for these two years mostly illustrates that there is substantial year-to-year variability in overwintering abundance.

The index areas established for these drainages are significantly larger than the index areas established for the Ivishak and Anaktuvuk rivers. During the surveys flown in 2007 and 2008, fish were distributed widely and very non-uniformly. Fish were observed and counted in sufficient numbers throughout the areas identified that the criteria used to establish index areas required index areas of this size, indicating that overwintering distribution in these two drainages is more dispersed than in the Ivishak or Anaktuvuk rivers.

The 2007 and 2008 counts on the Hulahula River can be compared with DIDSON sonar counts of in-migrating Dolly Varden conducted by the United States Fish and Wildlife Service. The preliminary counts from this project (M. Osborne, USFWS, personal communication) were 23,158 fish during 2007 and 12,340 fish during 2008. The proportion of the population observed during the 2007 aerial count compared to the number of fish migrating past the sonar site is substantially different from the proportion observed during aerial counts compared to mark-recapture abundance estimates in the Ivishak River (Viavant 2005). In the Ivishak River, aerial counts typically represented between 16% and 31% of the mark-recapture abundance estimate. The 2007 aerial count on the Hulahula River represented 41.3% of the 2007 DIDSON sonar count. The 2008 aerial count of the Hulahula represented 29.6% of the 2008 DIDSON sonar count, which is more consistent with the earlier results from the Ivishak River.

The difference in these relationships could result from many different factors, but the most logical explanation is the differences in distribution and density of fish as observed during aerial surveys. The index area on the Ivishak River is approximately 1/3 the size of the index area established on the Hulahula River, and in both years fish were widely distributed within the 69 km surveyed on the Hulahula River. Previous studies have suggested that aerial counts typically undercount abundance, and that this degree of undercounting is greatest at high densities of fish (Eicher 1953; Bevan 1961; Jones 1995). It is possible that because fish may have been more widely distributed in the Hulahula River during 2007 than in the Ivishak River during 2001 to 2003, and thus at lower densities, the degree of undercounting during aerial counts may have been lower.

CONCLUSIONS

Aerial counts of Dolly Varden in overwintering index areas in North Slope rivers should be viewed only as indicators of relative abundance. These results are useful in comparing stock status over time when collected consistently over a number of years. Counts within index areas from the Ivishak and Anaktuvuk rivers during 2006 to 2008 indicate overwintering abundances are within the range of historical comparable estimates. Because there is only a short and incomplete time series of comparable survey counts, it is difficult to make conclusions regarding stock status from available data; however, these recent index area counts from the Ivishak and Anaktuvuk rivers do indicate that there have not been significant declines in overwintering abundance.

These fish stocks provide for significant subsistence harvests. Because of the potential for effects on these stocks from increased use by recreational users and habitat effects from resource development or climate change, there is an ongoing need for some minimal level of stock status monitoring. Although aerial monitoring of overwintering index areas in a few major drainages provides only a relative assessment of stock status, when these surveys are conducted over time, this relative assessment would provide for detection of significant changes in stock status.

Conducting aerial index counts of overwintering Dolly Varden on the Kongakut River using a piston-engine helicopter based from the Dalton Highway presents challenges due to the long flight distances involved and the requirement to have aviation fuel staged in advance. These issues combined with the frequent occurrence of weather conditions that prevent flying suggest that attempts to conduct aerial counts on the Kongakut River should be based from Kaktovik.

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